Delta Smelt:
PVA, ESA, and the EWA

(the good, the bad, and the ugly?)

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Population Ecology of Delta Smelt in the San Francisco Estuary (a.k.a. the Whitepaper)

1. Should the species be listed under the ESA; what is the probability of extinction?

2. What is the role of human activities, particularly water export operations, on the population?

3. What are the potential restoration options?

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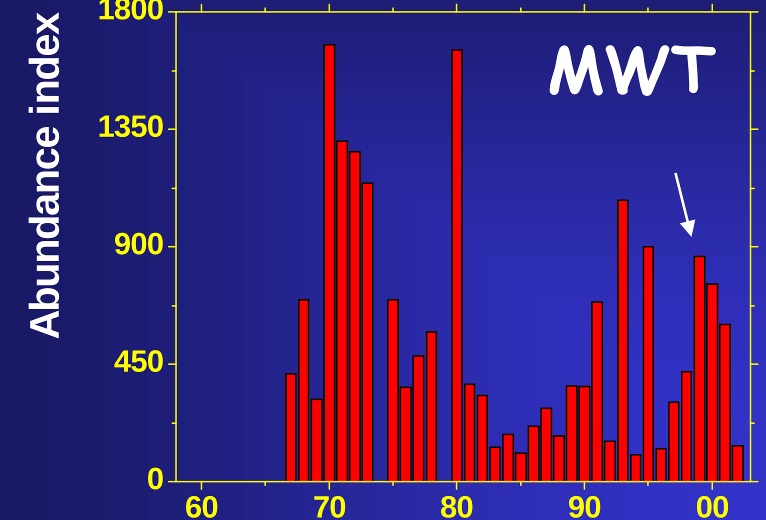
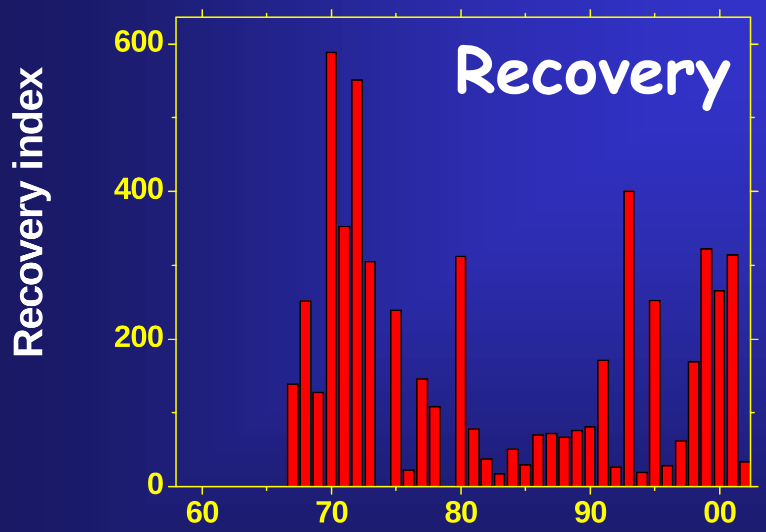
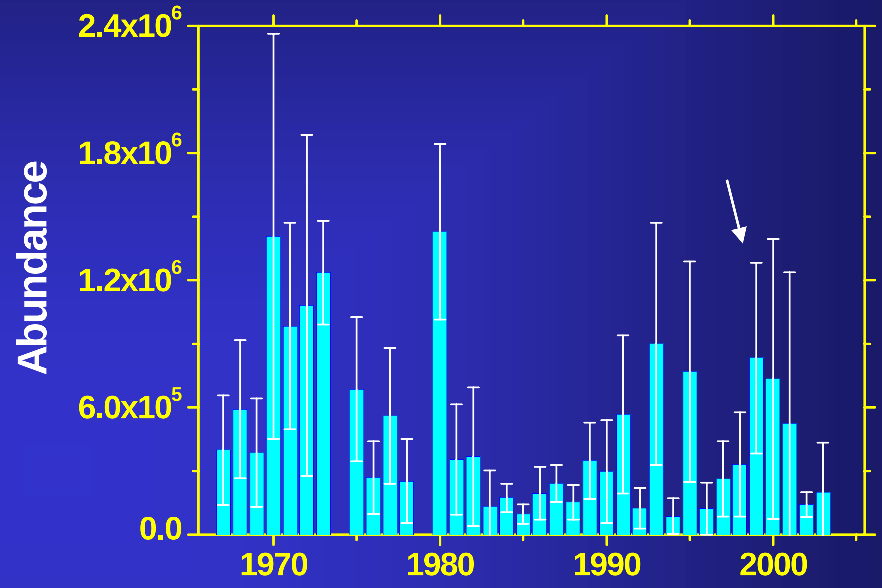




Adult Abundance



Assumptions

Net efficiency = 100%

Volume filtered =

7000 m^3 (MWT)

Question 1?

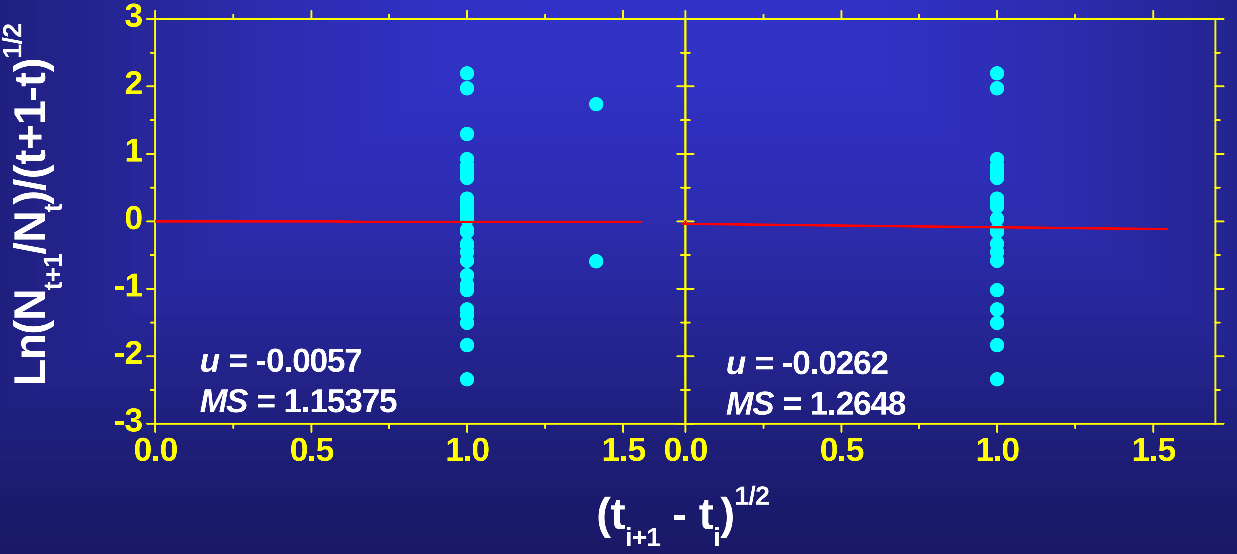
Probability of Extinction

B. Dennis et al. 1991. Ecological Monographs 61:115-143

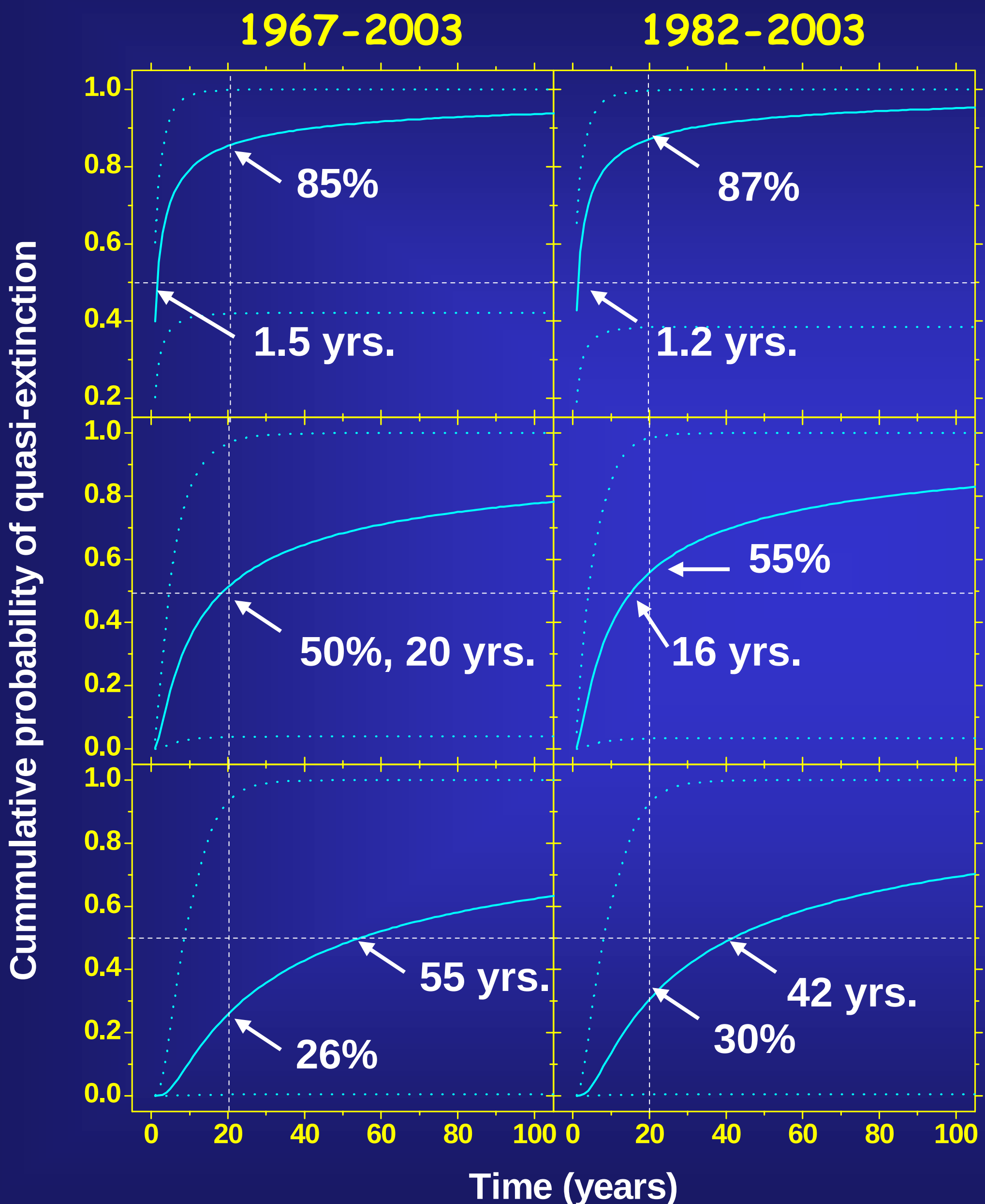
- Assume abundance over time will be lognormally distributed.

- Time until a population reaches an extinction threshold requires estimating
  - 💻 : (slope) the rate at which the mean of the distribution increases,
  - ☞^{2} : (mean square error) how fast the variance increases over time.

- Linear regression with zero intercept and abundance representing change between years.



Cumulative Distribution Function (CDF)



Summarize the times to extinction at 3 abundance levels

Extinction thresholds:

80000 (~lowest MWT index)

8000

800

International Union for Conservation of Nature and Natural Resources (ICUN)

Red List Categories and Criteria (2001)

- Extinct
- Extinct in the Wild
- Critcally Endangered

- Endangered 20% within 20 years

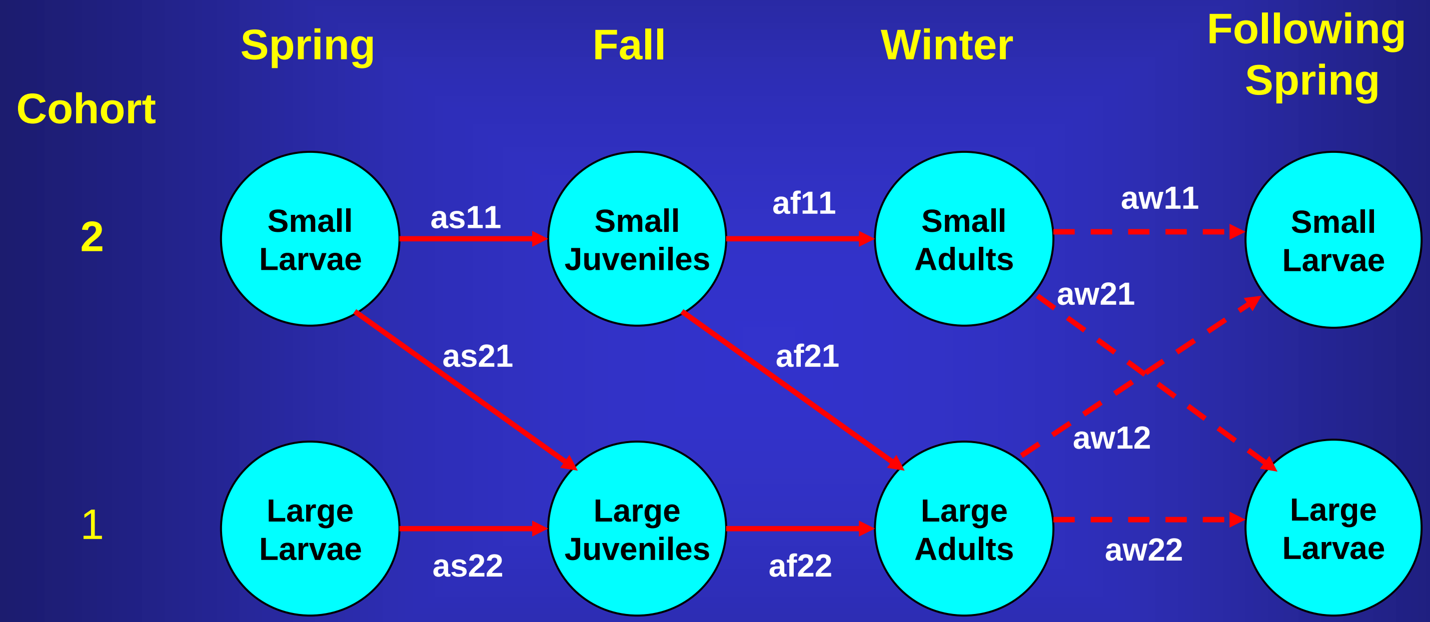
- Vulnerable 10% within 10 years

- Near Threatened
- Least Concern
- Data Deficient
- Not Evaluated

50% probability of reaching 8000 fish within 20 years!

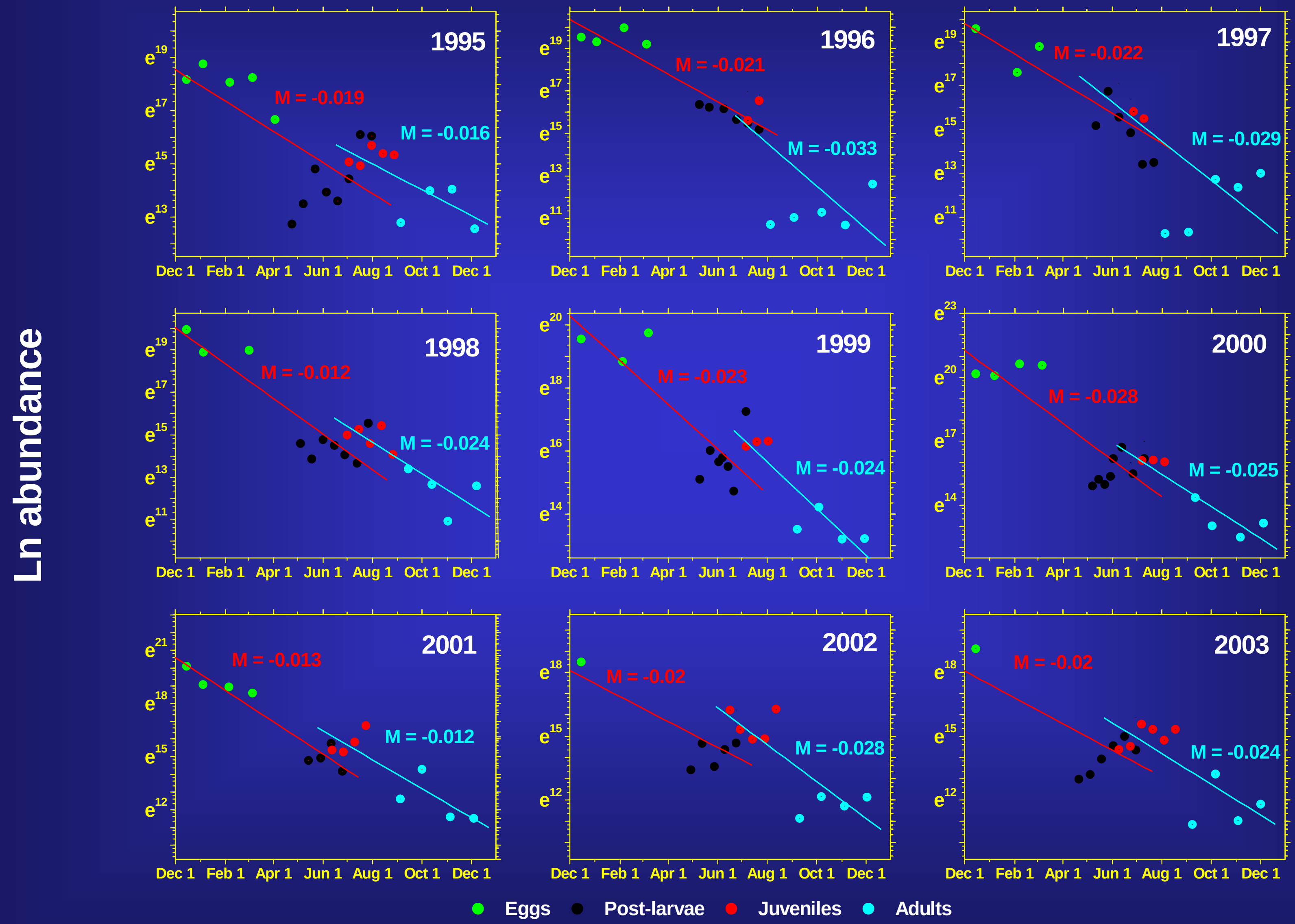
Question 2-3?

Periodic Stage-Based Population Model and Export Mortality

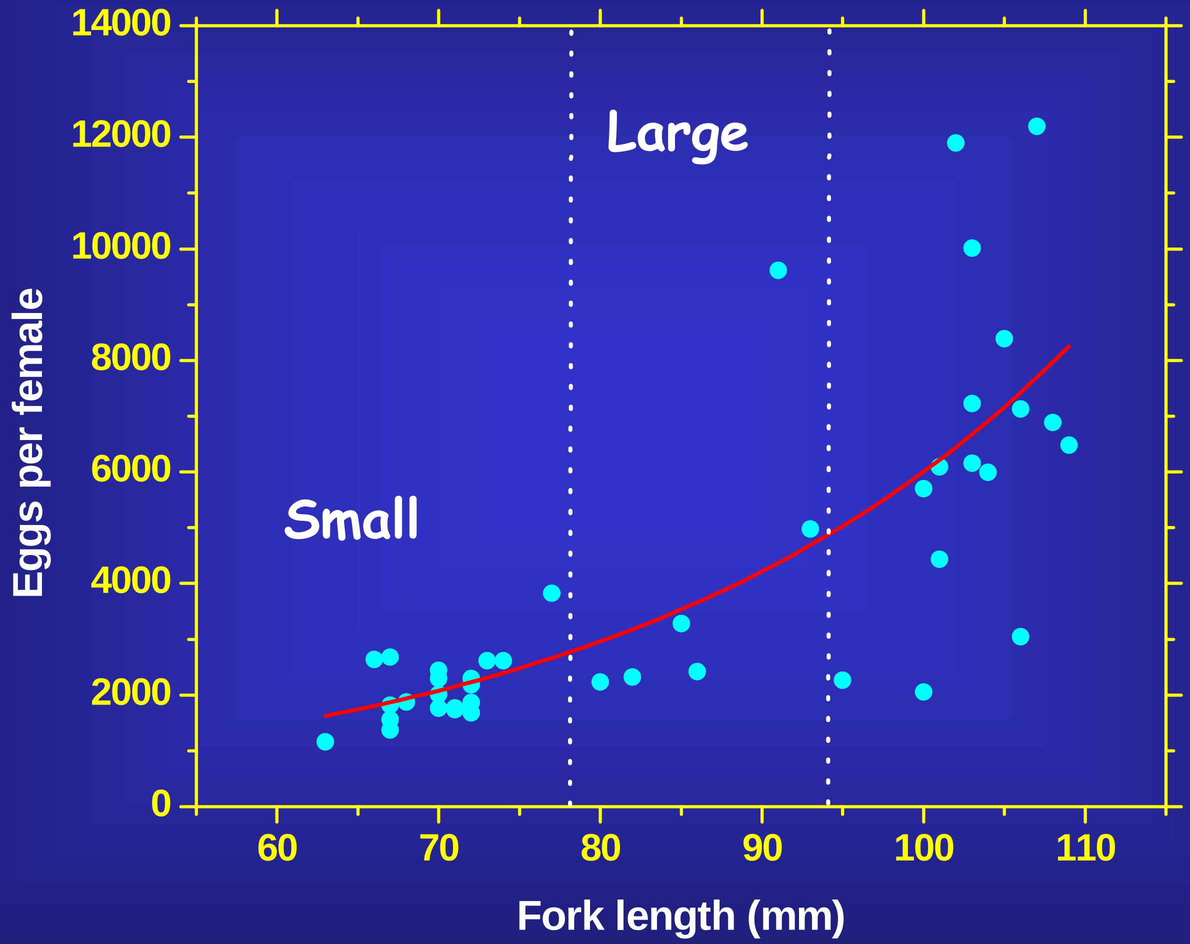


$$\begin{bmatrix} as11 & 0 \\ as21 & as22 \end{bmatrix} \cdot \begin{bmatrix} af11 & 0 \\ af21 & af22 \end{bmatrix} \cdot \begin{bmatrix} aw11 & aw12 \\ aw21 & aw22 \end{bmatrix} = A$$

Life Stage Specifc Mortality

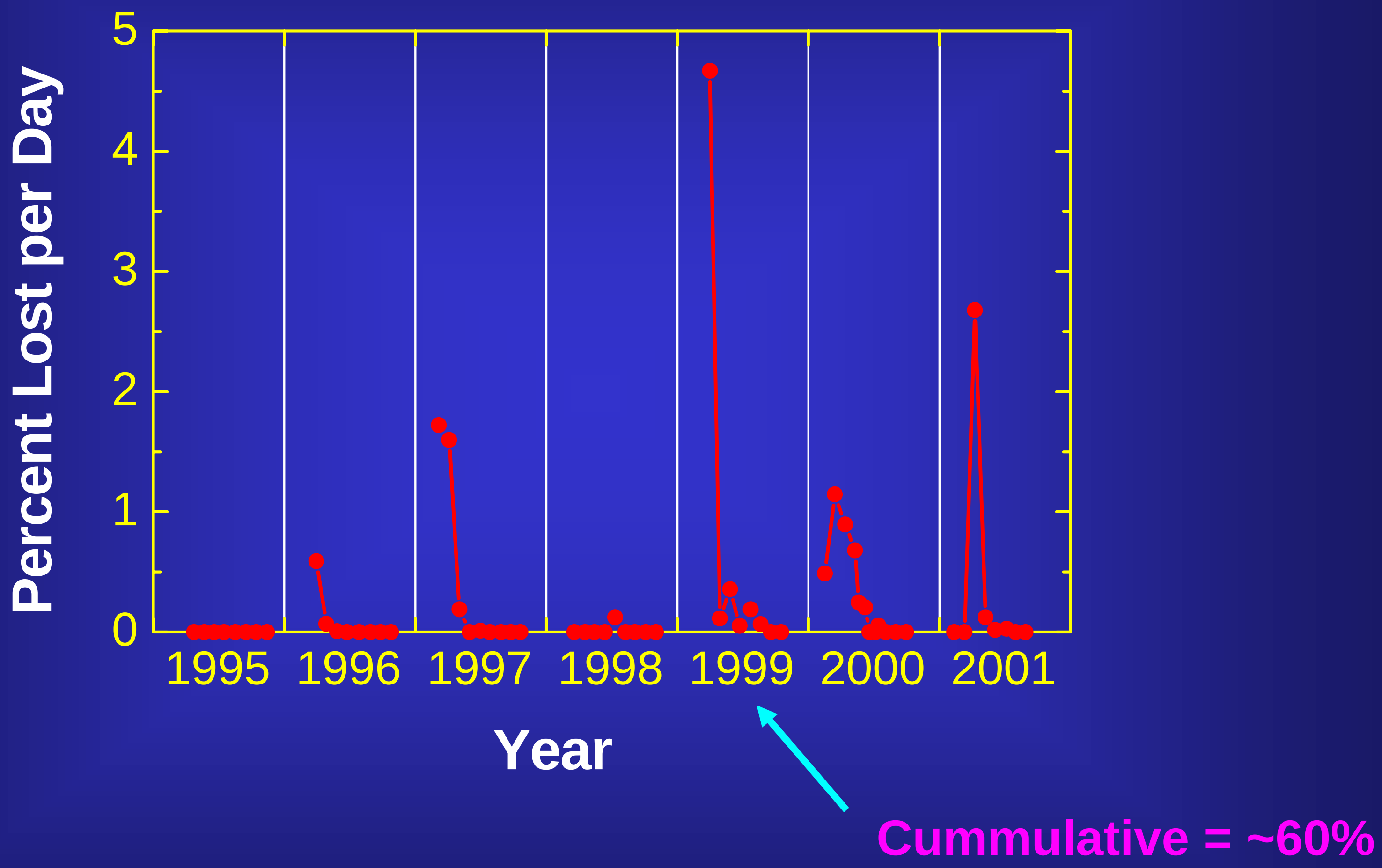


Fecundity



Large
Small
14000
12000
10000
8000
6000
4000
2000
0
Eggs per female
60
70
80
90
100
110
Fork length (mm)

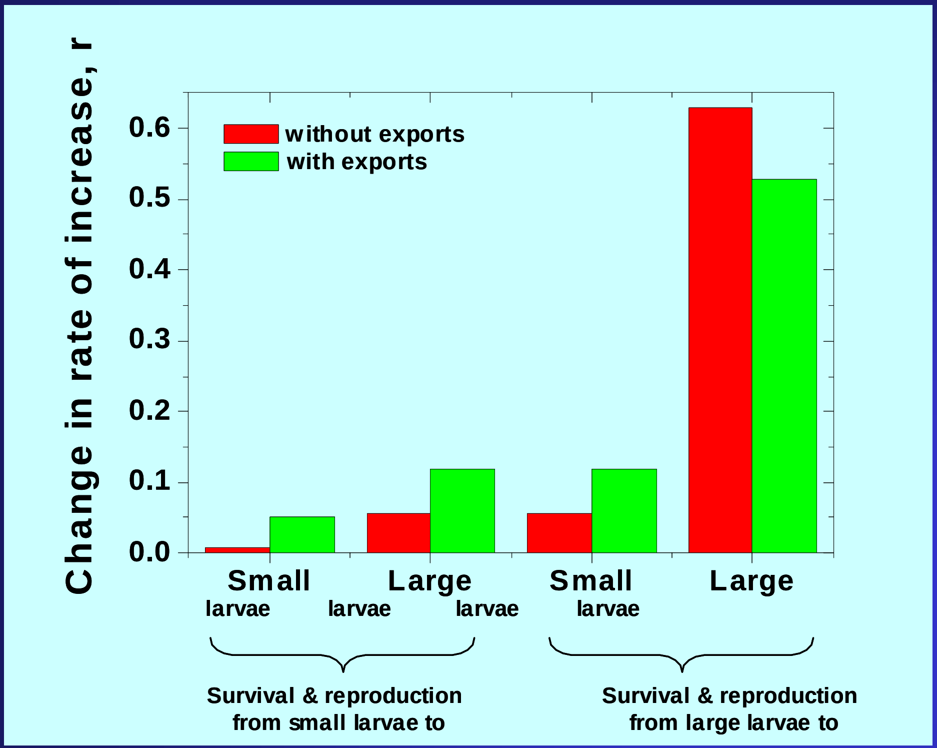
Daily Mortality due to Water Exports in 20mm Survey



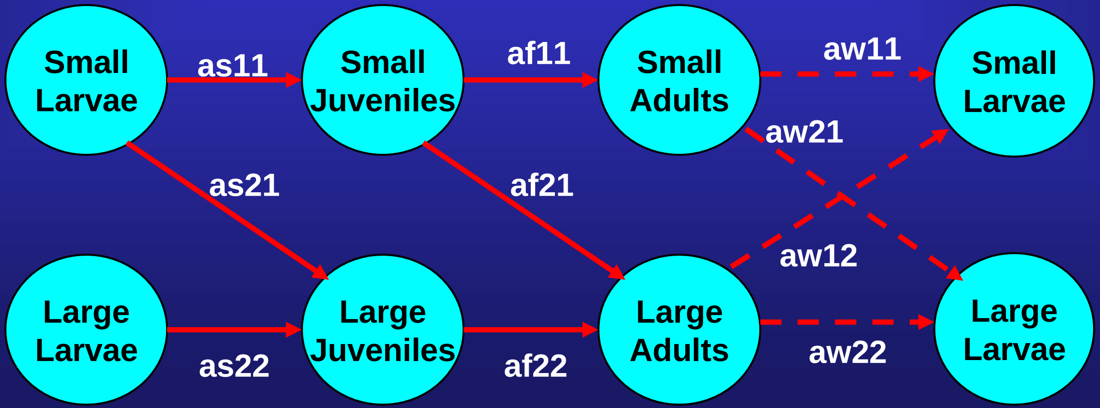
Parameters and Transitions

Transitions	Definition	Estimate
Parameters		
	Fecundity small female eggs	1870/2 = 935
	Fecundity large female eggs	3283/2 = 1642
Survival		
	Fall adult to spring adult	0.59
	Spring egg abundance to larvae	0.018
	Larvae to juvenile	0.83
	Exports during larval stage	0.40
	Juvenile to fall adult	0.09
Spring		
as11	Probability of small larvae becoming a small juvenile	0.83 x 0.75 = 0.62
as21	Probability of small larvae becoming a large juvenile	0.83 x 0.25 = 0.21
as22	Probability of large larvae becoming a large juvenile	0.83
as22*	Probability of large larvae becoming a large juvenile with export mortality	0.83 x 0.40 = 0.332
Fall		
af11	Probability of small juvenile becoming a small adult	0.09*0.75 = 0.067
af21	Probability of small juvenile becoming a large adult	0.09*0.25 = 0.023
af22	Probability of large juvenile becoming a large adult	0.09
Winter		
aw11	Number of small larvae produced by small adults	935*0.018*0.59*0.5 = 4
aw21	Number of large larvae produced by small adults	935*0.018*0.59*0.5 = 4
aw22	Number of large larvae produced by large adults	1642*0.018*0.59*0.75 = 13
aw12	Number of small larvae produced by large adults	1642*0.018*0.59*0.25 = 4

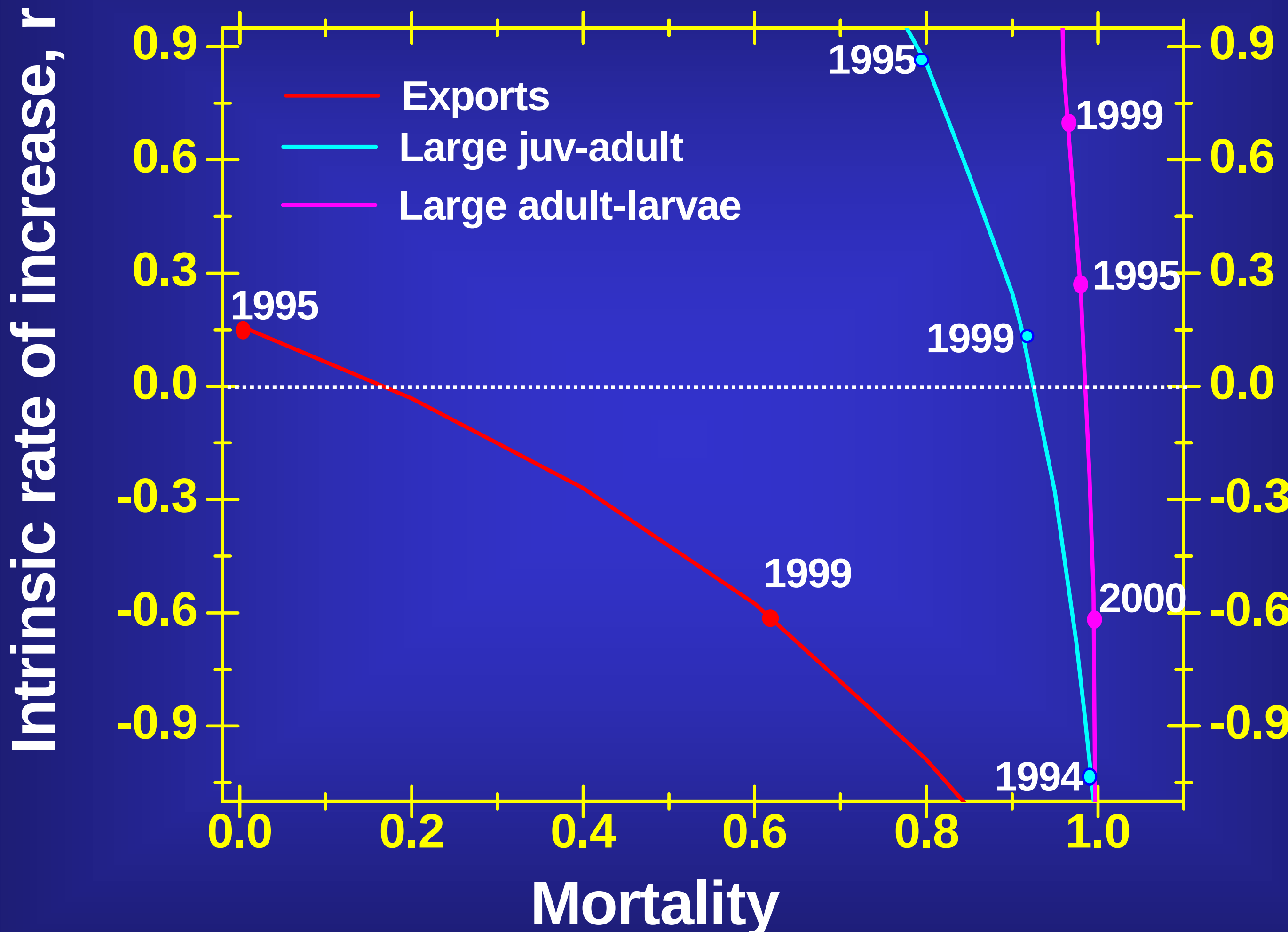
Model Sensitivity



Elasticities: what is the relative importance of each matrix element to population growth?



Changes in Parameter Values and Population Growth



Implications for EWA

1. Should the species be listed under the ESA; what is the probability of extinction?

YES, we do need to be concerned about restoration tools

2. What is the role of human activities, particularly water export operations, on the population?

Exports can have effects, but they may be offset or difficult to measure.

3. What are the potential restoration options?

Potential benefits of EWA may not be large enough to measure.

These answers aren't perfect!